



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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MEMORANDUM TO: Project Engineers
Project Design Engineers

FROM: G. R. Perfetti, P. E.
State Bridge Design Engineer

DATE: July 11, 2005

SUBJECT: BOX BEAM GUIDELINES

General

The Structure Design Unit shall consider the use of box beam girder bridges for locations where they are more economical than any other structure type. This policy memorandum presents the design and detailing guidelines for box beam bridges.

Box beams shall be detailed to the dimensions and section properties shown in Figure 6-127, and are to be designed for prestressing with straight strands. For approximate span length limits see Design Manual Figure 11-3. Specify high strength concrete only in spans where required by design. Box beams shall be constructed in a side-by-side layout, similar to the current practice with cored slab bridges.

Box beams may be used for skews between 60° and 120°, and on grades up to 4%. Box beams may be set on caps with a slope of 2% or less. When box beams are used on vertical curves, the 2'-8" (813mm) minimum dimension from the top of the wearing surface to the top of the barrier rail must be maintained.

The attached standards were developed for the use of a concrete overlay. For projects requiring an asphalt overlay, the standards will have to be slightly modified.

Design

For those projects requiring top-down construction or for projects with span arrangements that permit top-down construction, design the box beam units for top-down construction loads. For box beam bridges where none of the span lengths exceed 55'-0" (16.76m) the top-down

construction loads may be approximated with an HS-25 loading. However, for bridges where any of the spans exceed 55'-0" (16.76m), design all box beam units for the anticipated construction loads, such as operating and travelling crane loads. Refer to the EDS memorandum on Box Beam Design for analysis of crane loads.

When the Structure Recommendations specify a box beam bridge, the Roadway Project Engineer should recommend an overall (out-to-out) structure width that is an even 3'-0" (914mm) increment. When the Structure recommendations do not show the overall width to an even 3' increment but it is determined that box beams are the preferred structure type, the Structure Project Engineer shall increase the recommended out-to-out dimension to the next even 3'-0" (914mm) increment and inform the Roadway project Engineer of the necessary adjustment. See the form letters available via the Structure Design web page.

The camber and dead load deflection shall be shown for all box beam spans in the following manner:

Camber (Girder alone in place) = _____ ↑
Deflection due to Concrete Overlay = _____ ↓
Final camber (or deflection) = _____ ↑ or ↓

Cambers and dead load deflections shall be shown for the girder alone in place, and for deflections due to wearing surface. Do not include deflections due to the rail or the future wearing surface in the deflection due to concrete overlay.

All deflections and cambers shall be shown to the nearest sixteenth of an inch (mm). The camber and deflection at the time of erection is calculated based on "A Rational Method for Estimating Camber and Deflection in Precast Prestressed Members" as published in the PCI Journal, Volume 22, No. 1. This method applies multipliers to the initial camber and deflection to arrive at the camber at the time of erection. For this method, an average erection time of 28 days after casting is assumed and 65% of the camber is achieved by erection time.

For concrete overlays, show the dimensions for the minimum overlay thickness at mid-span and the overlay thickness at centerline bearing on the Typical Section. Indicate that the overlay thickness at centerline bearing is based on the predicted deflection due to concrete overlay.

The use of level, unreinforced pads is preferred. The pads shall be designed in accordance with the AASHTO Standard or LRFD Specifications. In general, use 6" (150 mm) by 5/8 inch (16 mm) pads as a minimum and provide 1¼" (32 mm) ϕ holes in fixed end bearing pads and 2½" (64 mm) ϕ holes in expansion end bearing pads for #8 (#25) dowels. Dowels shall be 2'-3" (685 mm) long set 1'-0" (300 mm) into the concrete cap. Do not apply epoxy protective coating to the bent caps of prestressed concrete box beam structures.

Detailing

The expansion joints shall be evazote joints with elastomeric concrete. If the thickness of the overlay at the rail is 4 ½" or more, detail a minimum concrete overlay thickness of 2 ¼" below a 2 ½" X 5 ½" blockout. If the thickness of the overlay at the rail is less than 4 ½", detail a full-depth blockout.

The barrier rail shall be placed such that there is a 1" offset from the edge of the exterior unit to the exterior face of the barrier rail. The barrier rail shall be attached to the exterior units by casting reinforcing steel into the exterior units and pouring the barrier rail after the units are post-tensioned, but prior to placement of the concrete overlay.

When required, a minimum sidewalk width of 5'-0" (1500mm) or 5'-6" (1650mm) shall be used unless otherwise recommended. Place the sidewalk and parapet so the offset from the edge of the exterior unit to the exterior face of the parapet is 1" (25mm). See the attached Figure 6-128. If the overall width is not in an even 3'-0" increment, increase the sidewalk width as necessary and inform the Roadway Project Engineer of any adjustment so the guardrail location, where necessary, can be adjusted accordingly.

Eight standard drawings are available and should be used in plan development.

- PCBB1 – 3'-0" x _'-_" Prestressed Concrete Box Beam Unit
- PCBB2 – 3'-0" x 2'-3" Prestressed Concrete Box Beam Unit
- PCBB3 – 3'-0" x 2'-3" Prestressed Concrete Box Beam Unit
- PCBB4 – 3'-0" x 2'-9" Prestressed Concrete Box Beam Unit
- PCBB5 – 3'-0" x 2'-9" Prestressed Concrete Box Beam Unit
- PCBB6 – 3'-0" x 3'-3" Prestressed Concrete Box Beam Unit
- PCBB7 – 3'-0" x 3'-3" Prestressed Concrete Box Beam Unit
- PCBB8 – 3'-0" x _'-_" Prestressed Concrete Box Beam Unit

Standards PCBB1 and PCBB8 shall be used in combination with Standards PCBB2-7.

The standard drawings provide general details. Some modifications or adjustments will be required to suit a particular structure. The barrier rails are detailed for a 3½" (90mm) concrete wearing surface measured at the gutter line at mid-span. The barrier rail reinforcing details should be modified where the concrete wearing surface exceeds the depth shown on the standard details. For use of a one or two bar metal rail, see Figure 6-130. The overlay shall be placed after the barrier rails have been constructed and have cured. Longitudinal joints in the overlay shall not be permitted, except where required for staged construction. Place the following note on the plans:

"Placement of the concrete overlay shall occur after casting the concrete rail [parapet]. For Concrete Wearing Surface see Special Provisions."

Detail the transverse joints on box beam bridges with evazote joints that incorporate the standard elastomeric concrete filled blockout. In addition, detail a backwall at the end bents.

Where debonded strands are required, indicate the strands to be debonded on Standard Drawings PCBB2, PCBB4, or PCBB6. Place the following note on the Standard Drawing:

Bond shall be broken on strands as shown for the specified length from each end of the box beam. See Standard Specifications Article 1078-7.

For the use of box beams at a corrosive site, see Section 12-13.

Diaphragms

Diaphragms shall be detailed along the skew and shall be located 8 feet from the ends in addition to the following locations:

- At the center of spans up to 60 feet (18.29 m),
- At third points of span lengths between 60 feet (18.29 m) and 85 feet (25.91 m), and
- At quarter points of span lengths over 85 feet (25.91 m).

June 21, 2005

See Figure 6-129. A pair of 2" (50 mm) ϕ holes, for the post-tensioning strands, shall be formed through the diaphragm and shall be located symmetrically about the mid-height of the box beam section. The post-tensioning strand shall be seven wire, high strength Grade 270, 0.6" (15.24 mm) ϕ , low-relaxation strands. The anchorage recess for the post-tensioning assembly shall be grouted as shown on the Standard Drawings.

This policy is effective with the October 2005 letting. The Standard Drawings are available via the network drive and Structure Design Web Page. The Design Manual will be revised at a later date.

Attachments

Standard Drawings [PCBB1](#), [PCBB2](#), [PCBB3](#), [PCBB4](#), [PCBB5](#), [PCBB6](#), [PCBB7](#), [PCBB8](#), [PCBBSM1](#), [PCBBSM2](#), [PCBBSM3](#), [PCBBSM4](#), [PCBBSM5](#), [PCBBSM6](#), [PCBBSM7](#), & [PCBBSM8](#)

Design Manual Figures [6-127](#), [6-128](#), [6-129](#), [6-130](#), [6-127SM](#), [6-128SM](#), [6-129SM](#) & [6-130SM](#)

GRP/GM/snj

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